1 Program 3dclust

1.1 Purpose

Program 3dclust is used to detect clusters of activation (i.e., nonzero voxels) in 3D datasets, and to report various statistics about the location and intensity of cluster activation. A cluster is defined as a set of points, each of which has a neighbor in the cluster that is no more than some given distance away (the 'connectivity distance'). If you select this connectivity distance as being just slightly over one voxel width, then clusters must be connected in a nearest-neighbor fashion. If the connectivity distance is a little over $\sqrt{2}$ times the voxel dimension, then next-nearest-neighbor (diagonal, in-plane) connections are possible. And so forth. For example:

3dclust 1.9 200.0 friday/func01+tlrc.HEAD

This says to examine the given dataset for clusters, using a 1.9 mm connectivity distance, and discarding all clusters that aren't at least 200 μl (mm^3) in volume. If the voxels are $1 \times 1 \times 1$ mm^3, then the 1.9 mm connectivity distance means that clusters will be connected by rectangular neighbors (1 mm away), in-plane diagonal neighbors ($\sqrt{2}$ mm away), or by out-of-plane diagonal neighbors ($\sqrt{3}$ mm away).

The above definition of cluster is used in program 3dmerge (see user documentation for program 3dmerge). Its application there is to edit out functional results that are not in a cluster.

The information about the clusters will be sent to stdout and will report their volumes, their centroid (center of mass, or CM), spatial extent of the cluster, the standard error of the mean (SEM), and their 'hot spot' (voxel with maximum value) coordinates. These coordinates are in the DICOM standard order, and it is easy to copy-and-paste them (using X11) for use as input to the Jump to chooser in *AFNI*.

At present, only one hot spot per cluster is reported. For large clusters, this may not be adequate for database (e.g., BrainMap) purposes.

1.2 Usage

The command line format for program 3dclust is as follows:

3dclust [editing options] [-summarize] [-noabs] rmm vmul dset ...

1.3 Options

rmm = cluster connection radius (mm). It is required that rmm be positive.

vmul = minimum cluster volume (micro-liters). It is required that vmul be positive. Note that (1 mm)^3 is 1 micro-liter.

dset = input dataset (more than one allowed).

-noabs The -noabs option uses the signed voxel intensities (not the absolute values) for calculation of the mean and SEM.

-summarize The -summarize option will write out only the total nonzero voxel count and volume for each dataset.

The report is sent to stdout.

1.4 Notes

- The editing options are as in 3dmerge.
- The program does not work on complex-valued datasets!
- The center of mass calculations make use of the intensity at each point.
- Cluster calculations are all done on the absolute value of the intensity; hence, positive and negative voxels can be grouped together into the same cluster, which may skew results. As an alternative, one could use the -1noneg option or the -noabs option.
- The standard error of the mean (SEM) values are not realistic for interpolated data sets (because comparisons are not independent). A *rough* correction is to multiply the interpolated SEM of the interpolated data set by the square root of the number of interpolated voxels per original voxel.

1.5 Example

Example 1.

An investigator wishes to examine *AFNI* dataset file fred.test07.run35+tlrc (both .HEAD and .BRIK files must be present) for clusters of activation. A possible input command line sequence is as follows:

3dclust -1noneg -1thresh 0.5 2 500 fred.test07.run35+tlrc

This command line tells program 3dclust to identify clusters of active voxels, considering only those voxels whose intensity is non-negative, and whose threshold value is above 0.50. A voxel is "connected" to another voxel if the voxels are $\leq$ 2 mm apart. Further, only clusters having a volume of 500 mm^3 or more are considered.

The program would then send to the standard output (such as the user's terminal) the following report:

Cluster report for file fred.test07.run35+tlrc
[Connectivity radius = 2.00 mm Volume threshold = 500.00]

[Single voxel volume = 1.0 (microliters)]
[Voxel datum type = short]
[Voxel dimensions = 1.000 mm X 1.000 mm X 1.000 mm]

Volume	CM RL	CM AP	CM IS	minRL	maxRL	minAP	maxAP	minIS	maxIS
17059	-5.3	70.7	47.4	-49.0	35.0	29.0	99.0	11.0	72.0
3384	36.7	75.7	17.8	22.0	50.0	56.0	89.0	-1.0	37.0
1680	-17.2	67.2	-2.5	-31.0	-4.0	58.0	76.0	-12.0	13.0
1086	-28.6	4.4	51.3	-38.0	-18.0	-1.0	12.0	40.0	68.0
920	35.9	39.7	43.9	26.0	50.0	33.0	50.0	36.0	54.0
795	12.0	67.0	0.7	4.0	21.0	60.0	80.0	-4.0	7.0
725	-47.2	73.0	7.5	-52.0	-35.0	65.0	81.0	0.0	15.0
646	26.2	3.6	48.6	15.0	39.0	-1.0	8.0	44.0	56.0
535	-40.5	-0.3	37.0	-49.0	-32.0	-9.0	4.0	28.0	45.0
26830									

Mean|*|	SEM	Max Int	MI RL	MI AP	MI IS
641.21	2.5049	2717	-12.0	73.0	58.0
448.92	2.7841	1205	41.0	80.0	21.0
517.87	3.8714	971	-8.0	59.0	11.0
460.21	3.7005	784	-30.0	5.0	63.0
393.92	3.7619	732	27.0	39.0	41.0
422.13	4.353	722	9.0	66.0	-2.0
515.05	7.3938	1183	-51.0	75.0	9.0
411.84	4.725	686	31.0	3.0	46.0
405.86	5.3017	709	-37.0	2.0	34.0
573.31	1.7778				

From the output, we see that 9 clusters (each having a volume of at least 500 mm^3) have been identified. The first column lists the volume of each cluster (which, in this case, is numerically equal to the number of voxels in the cluster, since each voxel has volume $1mm^3$). The 2nd, 3rd, and 4th columns give the center of mass of the cluster, in the R-L, A-P, I-S coordinate system. The 5th through 10th columns give the spatial extent of the cluster, in terms of the minimum and maximum voxel coordinates in the R-L, A-P, and I-S directions. The 11th column lists the average absolute value of the intensity of the voxels within the cluster. The 12th column gives the cluster intensity standard error of the mean (SEM). The 13th column lists the (signed) maximum intensity of a voxel within the cluster. Finally, the 14th, 15th, and 16th columns give the coordinates of the voxel having the peak intensity within the cluster, in the R-L, A-P, I-S coordinate system.

The last row of the table lists the total volume of all clusters combined, the average absolute value of the intensity of all voxels in all clusters, and the standard error of the mean (SEM) for all voxels in all clusters.